



Human Research Facility (HRF)
Rack Systems TIM

HRF FR1A and FR2/2A

Dec. 7, 2001

Human Research Facility

Rack Systems

Technical Interchange Meeting

December 7, 2001





Rack Systems TIM - Agenda

- Introduction of Presenters (Leger)
- Background / History (Leger)
- Systems Engineering Update and Verification Overview (Barb)
- Certification Process and Configuration Control Overview (Leger)
- Flight Rack Plan Overview (Aguilar)
- Flight Rack 1A Configuration (Aguilar)
- Flight Rack 2/2A Configuration (Witt)
- Issues and Risk Summary (Leger)
- Auction Item Review (Leger)





Meeting Objectives

- Purpose of the TIM is to:
 - Explain processes
 - Certification
 - Verification
 - Integration and Test
 - Configuration
 - Show changes to FR1 to configure FR1A
 - Discuss adding Rack 2/2A to the complement of on-board equipment
 - Outline the Integration Plan for Flight Racks
 - Identify Program issues and risks





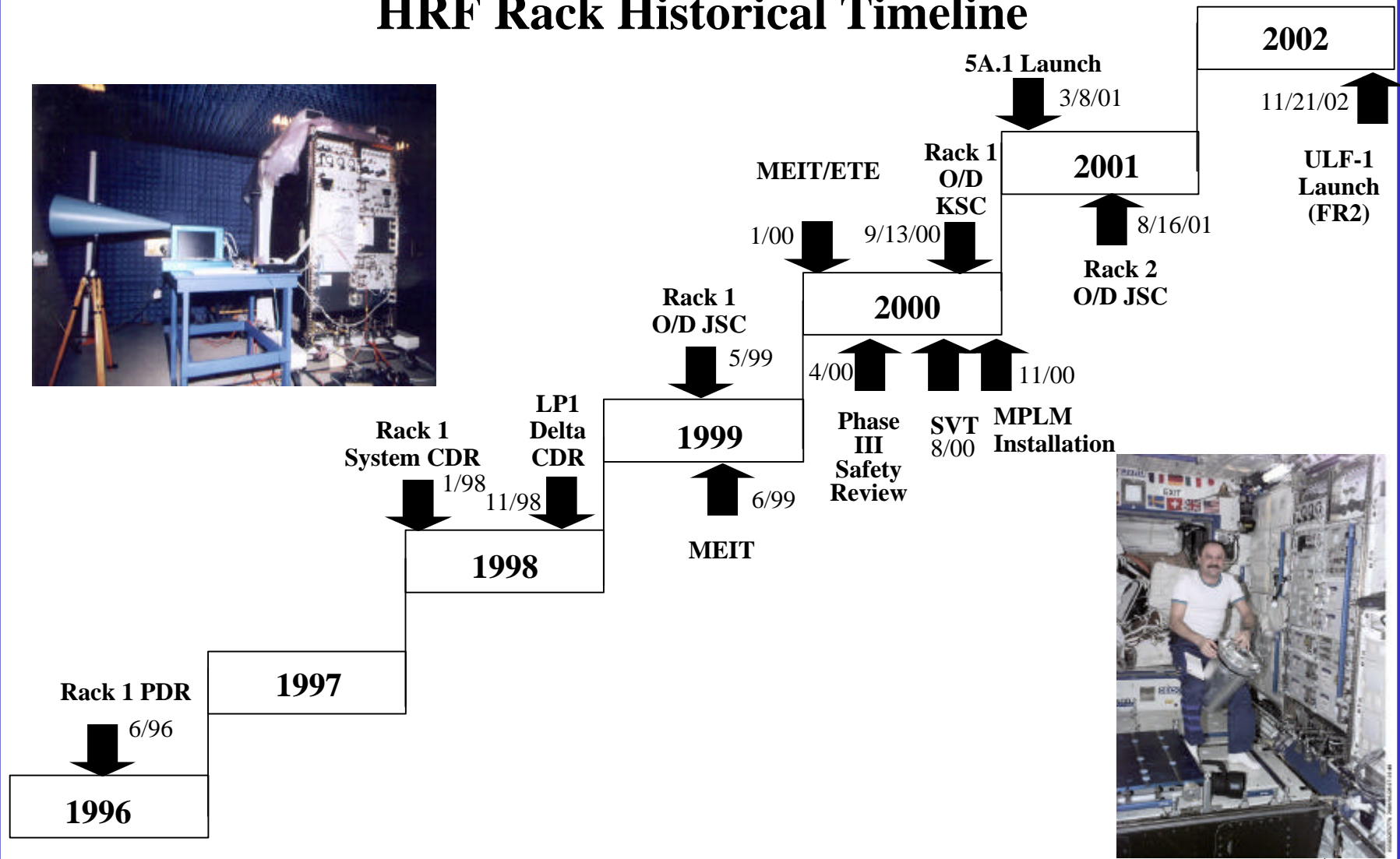
Human Research Facility (HRF) Rack Systems TIM

HRF FR1A and FR2/2A

Todd Leger

Dec. 7, 2001

HRF Rack Historical Timeline





HRF System Update

- FR2 scheduled for launch Nov. 21, 2002 on ULF-1/STS-114 for installation into US Lab location LAB1O3 (calendar now at L-11)
- Instruments from FR1 and FR2 will be exchanged to meet configuration objectives resulting in FR1A and FR2A
- Configurations are controlled by the HRF CCB – baselined on May 2001
- Scope of the configuration changes affect structural, thermal, microgravity, power, EMI/EMC, HFE, operations, training, verification, etc.
- FR2 empty rack is supplied by EXPRESS as a recurring unit of the FR1 design with minor modifications (improved alignment and labeling)
- The design of the HRF empty rack is established by the EXPRESS document Prime Item Development Specification (PIDS), updated to SSP 57000E (Nov. 2000)
- The design of HRF 1A and 2A instruments were established at instrument PDRs and CDRs and are controlled by HRF CCB





Human Research Facility (HRF)
Rack Systems TIM

HRF FR1A and FR2/2A

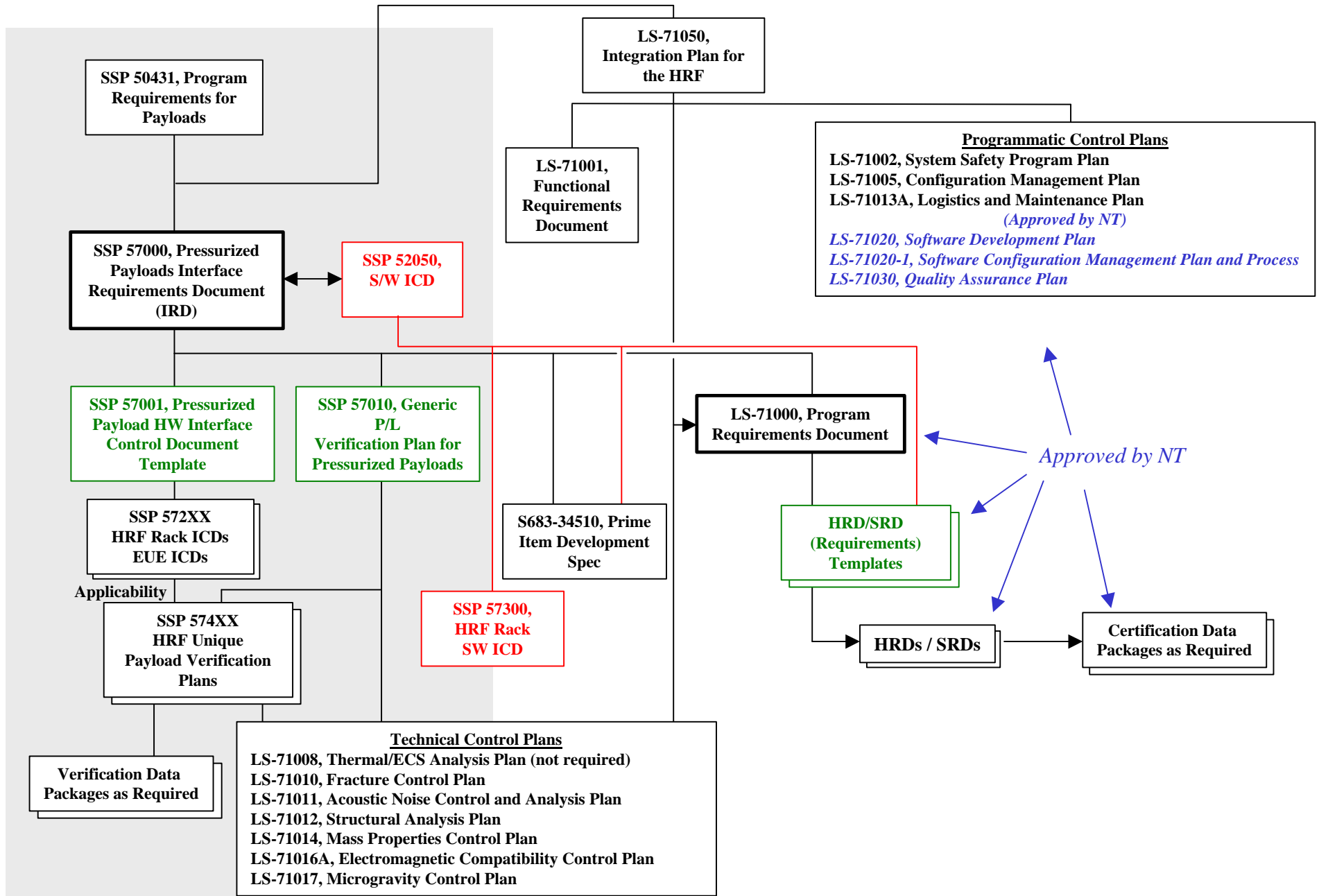
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HRF Systems Engineering Update

Dave Barb



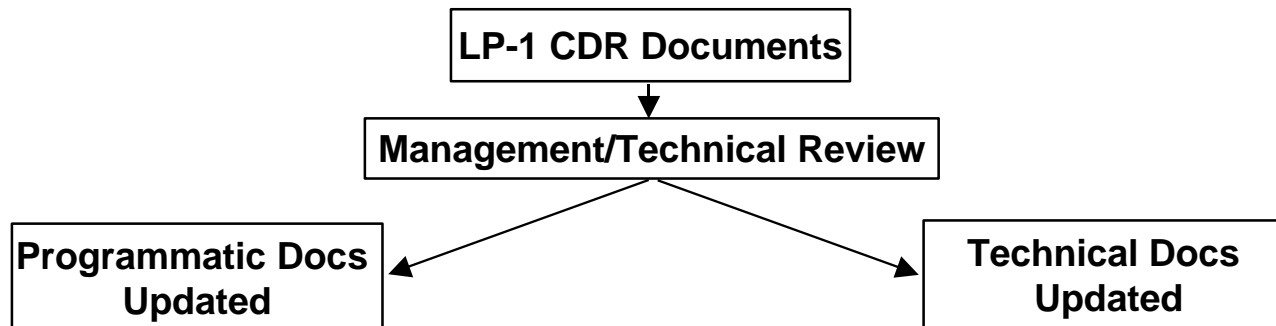
HRF Document Tree





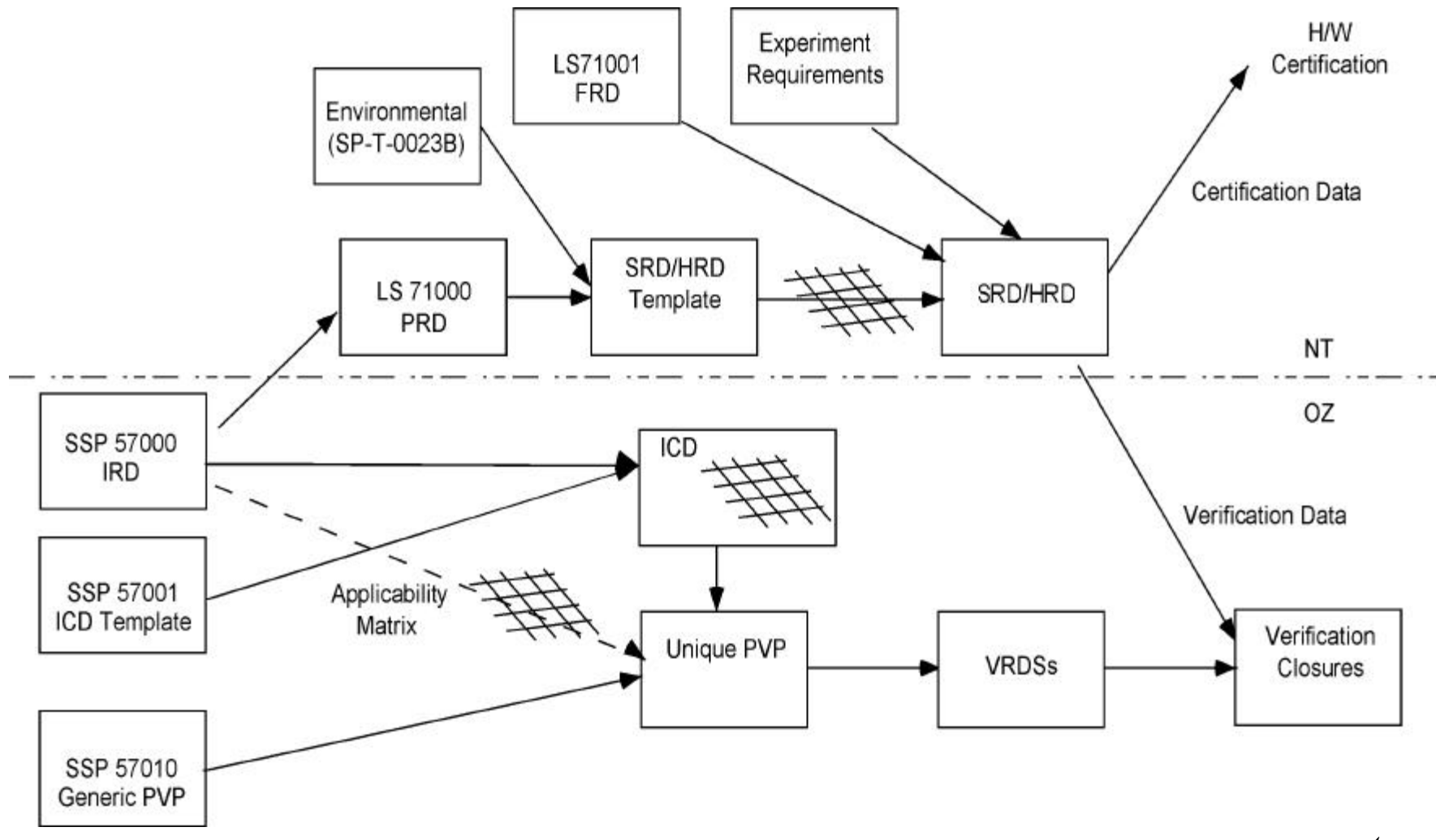
HRF Control Plans Update

- Reviewed all HRF LP1 Systems CDR documents for applicability.
- Selected documents for update based on program need and currency of existing document.
- Following CCB, LM review process for updating
- Book Managers updating Programmatic documents on an as-needed, case-by-case basis (e.g. PRD, SIVP, QA Plan, Logistics & Maintenance)
- Discipline Engineers updating Technical Control Plans to match current HRF technical requirements (SSP 57000E) and processes
 - Some Technical Control Plans are deliverable per SSP 57010 GPVP



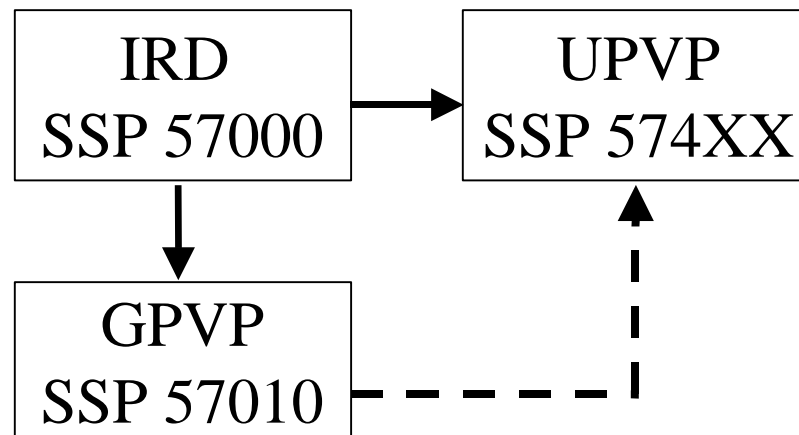


Requirement Development and Verification Closure Process





UPVP Highlights



- Rack 1 - UPVP SSP 57400
- Rack 1A - Appendix to SSP 57400
- Rack 2/2A UPVP – SSP 57452
- EUE UPVP – SSP 574XX





VRDS Closure Process

- Negotiate applicability with OZ3
- Generate or update UPVP
- Assign sponsors to specific requirements
- Inspection, Demonstration, Tests, and/or Analysis performed
- Assessment of performance to UPVP requirements
- Verification Requirement Data Sheets (VRDSs) closures written, reviewed, and signed by sponsors, SE&I, NASA/EB, and Safety when required
- Submit VRDS closures to OZ3 with Closure Products
 - CoCs, Test Reports, Analysis reports, Control plans, Drawings
- Exceptions follow established ISS PIRN process

[Click for PIRN
Implementation
Process](#)

[Click for VRDS
Process Flow
Chart](#)





RCAR Requirements Change Assessment Report

- RCAR submittals based on deltas (PIRNs) since baseline
 - SSP 57000C for FR1
 - SSP 57000E (Nov. 2000) for FR2
- Performed on a per-flight basis
- Assessment for requirements changed or added since VRDS closures submitted





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HRF FR1A and FR2/2A

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Certification and Configuration Management Process Overview

Todd Leger





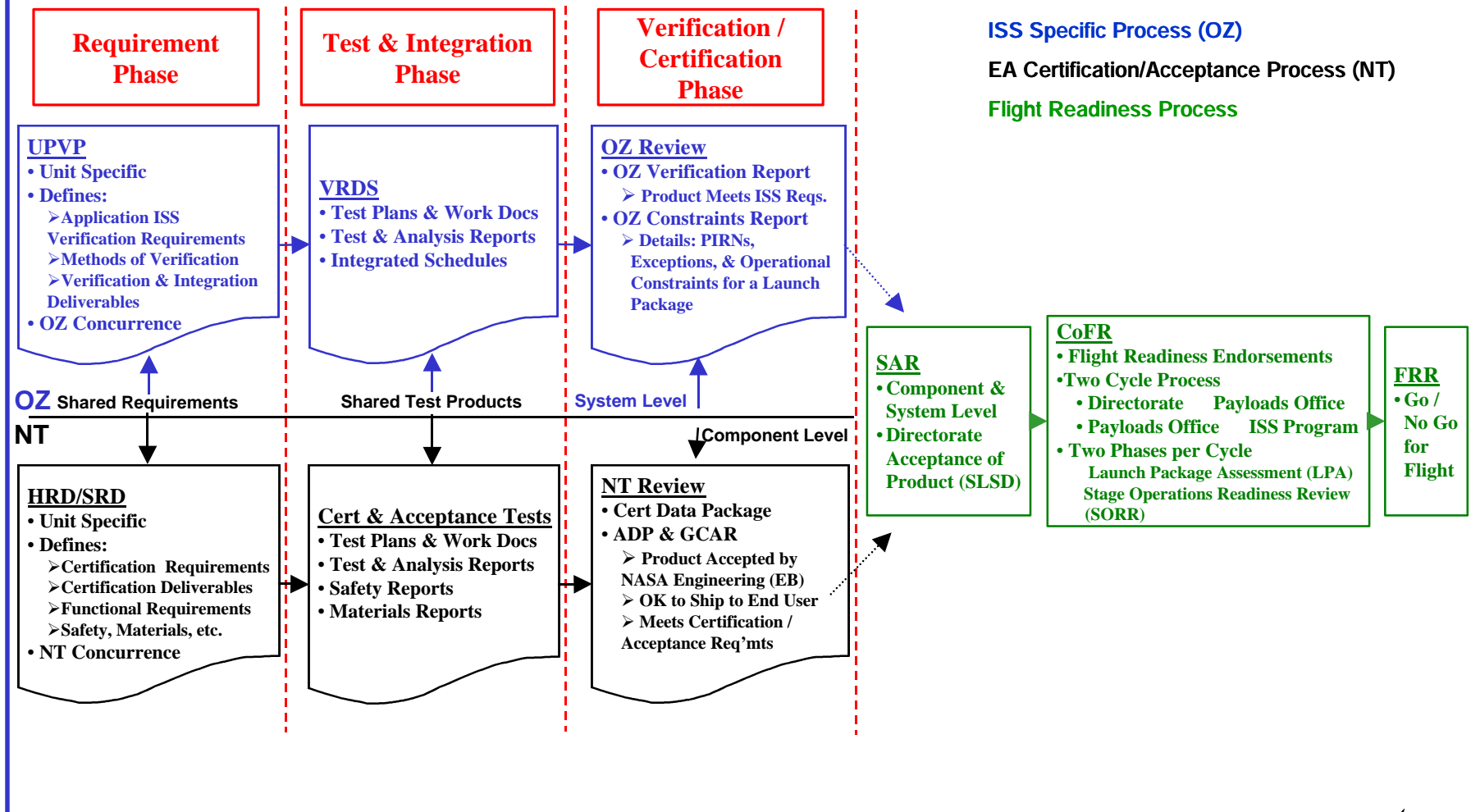
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Verification/Certification/Flight Readiness





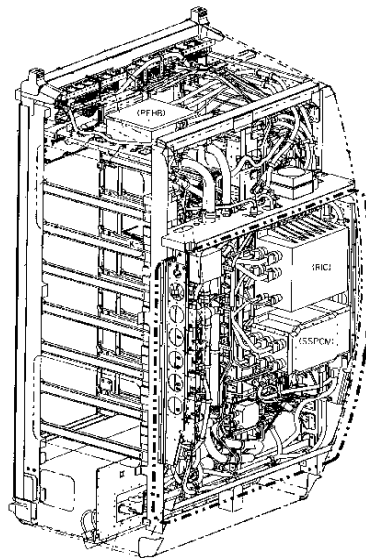
Human Research Facility (HRF) Rack Systems TIM

HRF FR1A and FR2/2A

Todd Leger

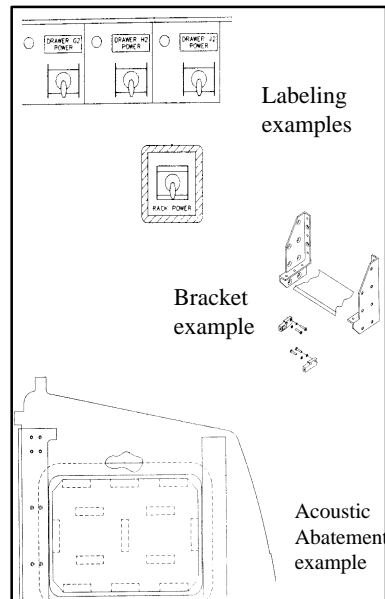
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Certification Overview



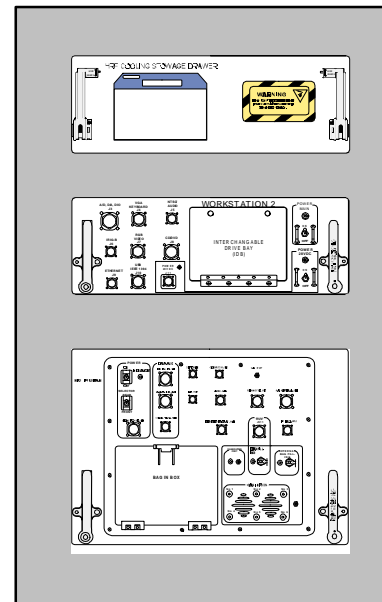
Empty Rack

Certified by Boeing
EXPRESS/MSFC
through FCA/PCA



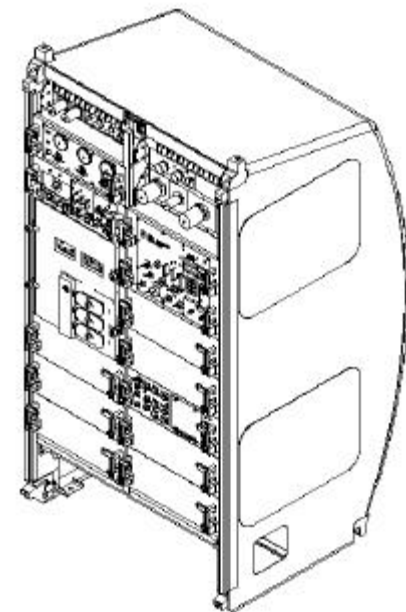
Outfitted Rack *HRF PC Integrated S/W Load*

Certified at JSC
through ADP/GCAR
Process



Instruments *Workstation Integrated S/W Load*

Certified at JSC
through ADP/GCAR
Process



Integrated Rack

No Unique Certification
Package
Verified via UPVP Process



Rack Certification Plan

- Certify the Components, Verify the System
 - No requirement goes unchecked
 - HRDs/SRDs incorporates all requirements specific to the component
 - UPVP verification process covers integrated system
 - Integrated configuration will be tested and analyzed
 - OZ and/or SM responsible for system CoFR statement
 - Negates duplicated effort and processes experienced with Rack 1
 - Aligns certification approach with modular design of equipment





Rack Certification Plan, Concluded

- Integrated Software products certification tied to applicable component
 - HRF PC Integrated Load = Outfitted Rack (HRF PC sub-assembly)
 - HRF Workstation Integrated Load = HRF Workstation
- Outfitted Rack certification will address modifications to EXPRESS/MSFC certification
 - Use HRF CCB directives as requirements
 - Will encompass all changes made at JSC
 - Software
 - Acoustic Abatement
 - Mechanical Modifications
 - Labeling
 - Materials and Mass





Process for Future Configuration Changes

- Use Rack 1A as the model
 - See Integration Plan (next section in this presentation) for details
- Develop a Configuration Definition Document for future purposes
 - Defines rack and instrument configurations, scenarios, software, etc.
 - Alternative for engineering drawings which are not verifiable for on-orbit hardware
- HRF CCB will be used to define and control integrated rack configuration
- Certify the components, Verify the system
 - All Rack components certified through NT
 - Integrated Rack configurations verified through OZ





Human Research Facility (HRF)
Rack Systems TIM

HRF FR1A and FR2/2A

Todd Leger

Dec. 7, 2001

Simplified Process for Configuration Changes

HRF Engineering

Determine
Configuration

Prepare ICD,
PVP Appendix,
Config. Def. Doc.

Test Planning
and Execution

HRF CCB

Review / Approve
Configuration

Baseline
Configuration
Definition Doc.

Data Packages

Initiates Process for
Exceptions

NT

CCB Participation

Approve
Configuration
Definition Doc.

Test
Participation

Certification
Package Approval

OZ

Establish ICD,
PVP Appendix

Provide Test
Tools and
Procedures

Verification
Package Approval



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Flight Rack Plan FR1A & FR2/2A

Carlos Aguilar
Elton Witt



Flight Rack Plan - Configuration Management

- Develop Rack configuration using inputs from multi-disciplined committee including thermal, human factors, operations, etc.
- Maintain Rack configuration through HRF CCB
- Develop configuration definition document for future test purposes
- Utilize LIF Configuration Control and Definition process
- Develop on-orbit stowage reconfiguration plans with HRF Stowage
- Document test configurations in Test Plans and on TPSs
- Submit all TPSs to QE for review/approval
- Maintain software configuration per Software CM process





Flight Rack Plan – Physical Integration

- Integrate FR1A instruments with the FPR in the B241 Launch Integration Facility (LIF)
- Integrate FR2/2A instruments with FR2 in the B241 LIF
- Juggle and swap instruments to support completion of certification testing
- Perform off-line tests of instruments prior to installation
- Perform fit checks prior to powered operations
- Perform bonding checks after first installation and prior to all electrical verification tests (EMI, power quality)
- Conduct on-line tests of instruments following installation
- Utilize published procedures to facilitate repeated operations





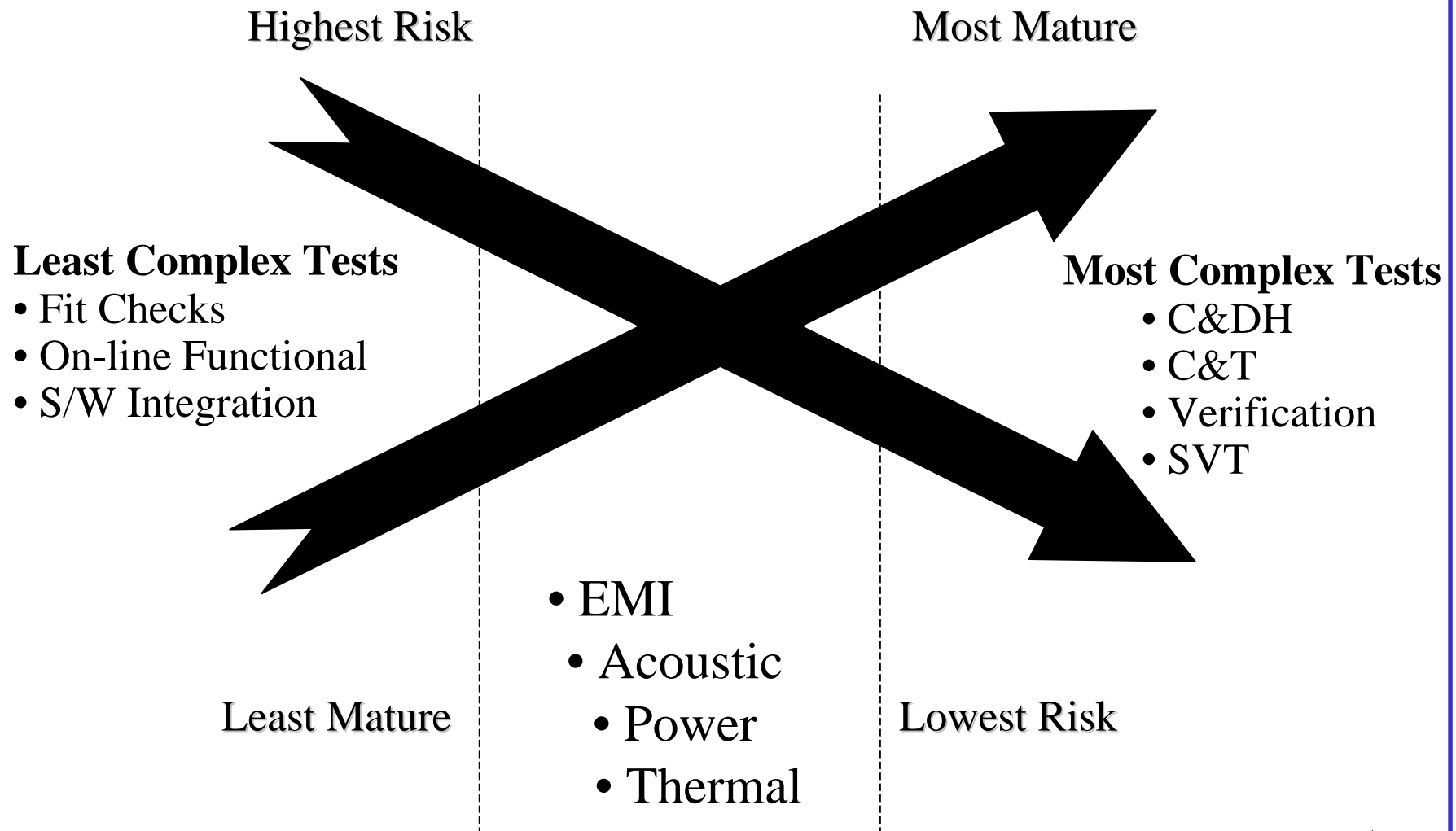
Flight Rack Plan – Test Phase

- Perform testing on integrated rack configurations
 - Integration – engineering and safety, off-line and on-line functional
 - Verification – hardware and software vs. UPVP requirements
 - Mission Success – Science Verification Tests, on-orbit profiling
- Conduct Test Readiness Review for B241, B14, KSC prior to activity
- Create generic procedures (Green Books) to allow testing multiple configurations of racks and hardware in various facilities
- Develop detailed test plan and schedule based on available resources (LIF, PRCU, GSE, test conductors) and instrument maturity
 - Tests tied to a specific VRDS and subsequent delivery date of VRDS closures
- Integration test complexity will increase as instrument maturity increases (see next slide)





Test Plan Risk Mitigation





Flight Rack Plan – Verification/Certification

- **Verification**
 - Update Rack 1 ICD for the FR1A (re)configuration
 - Update Rack 1 UPVP with a FR1A applicability matrix added to the appendix
 - Create Rack 2/2A ICD and UPVP
 - Assign VRDS sponsors and follow VRDS process
 - Submit Exceptions for VRDS not successfully verified
 - Follow CoFR process for stage ULF-1 for FR2 launch package
- **Certification**
 - Utilize building-block approach
 - Certify integrated software load (I7)
 - New FR1A/FR2A instruments will be certified by NT
 - Determine if FR1 hardware (US, CSD, GASMAP) will required GCAR update





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Rack Systems TIM

HRF FR1A and FR2/2A

Lindy Kimmel

Dec. 7, 2001

Flight Rack Plan - Verification Products Plan

- Structural – Participate in LP DLA, VLA, and O-O Assessments
- Thermal – Determine flow rates, delta temperature, and touch temp by analysis, based on test data from instruments (current draw)
- Delta Pressure- Determine by test with water cart and PRCU for flight flow rates
- Air Flow – Assess FDS requirement for operational scenarios, verify by test and analysis
- Acoustics –Sound Pressure and Sound Power test FR1A and FR2A in EMI lab, develop or update acoustic model for on-orbit change-outs
- Microgravity – Assess operational scenarios using model supported by component test data
- Power – Perform ISS Power Quality Tests with PRCU
- EMI/EMC – Perform ISS Tests in EMI lab using FR2
- Human Factors – Assessment in J241
- Software – Installation followed by Integration tests

Analysis and Testing is virtually unchanged from FR1



Flight Rack Plan

- Reliability
 - Follow process outlined in LS-71000, Program Requirements Document
 - Provide updates to the HRF L&M Life Limited Item List (LLIL)
- Safety
 - Follow standard PSRP Reviews for Instruments
 - FR1A & FR2/2A go straight to Phase III Safety Reviews
- Software
 - Develop, test, and certify Integrated software load for FR1A and FR2A at JSC in the LIF
 - Create a Software Test Procedure to document software process and minimize paperwork



Flight Rack Plan - Operations

- On-orbit check out of flight rack hardware and software will be requested and supported
- SE&I will work with Ops to develop and validate procedures to configure FR1 into FR1A and FR2 into FR2A
- SE&I will work with Ops to update flight rules
- Operations will provide the operational scenarios flight configurations that will need verification data
- Involve Operations Increment 7 Manager through all phases of flight rack integration and verification
- Conduct transition TIM (hand-over from SE&I to Ops)



Current/Potential Exceptions Table

| <u>System</u> | <u>Description</u> | <u>Applicable Rack</u> |
|---------------|---|------------------------|
| Thermal | Delta Pressure | 1,1A, 2A |
| | EXPRESS Flow Control Valves Time Constant | 1/1A, 2A |
| | MTL Return Delta Temperature | 1/1A, 2A |
| Acoustic | Rack Only Continuous Operations Scenario | 1/1A, 2A |
| | Extended-period Continuous Operations | 1/1A, 2A |
| Human Factors | Connector Spacing | 1/1A, 2/2A |
| | Labeling and Protrusions | 1/1A, 2/2A |
| Electrical | EMI TIAs | 1/1A, 2A |
| | Electrostatic Discharge | 1/1A, 2A |
| | Corona (Instruments) | 1/1A, 2A |
| Microgravity | SLAMMD | 1A |
| | Refrigerated Centrifuge (TBD) | 2A |



HRF Flight Rack 1A

Carlos Aguilar

Configuration

Project Specifics

Milestones and Schedule

Risk and Mitigation



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HRF FR1A and FR2/2A

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FR1A Configuration

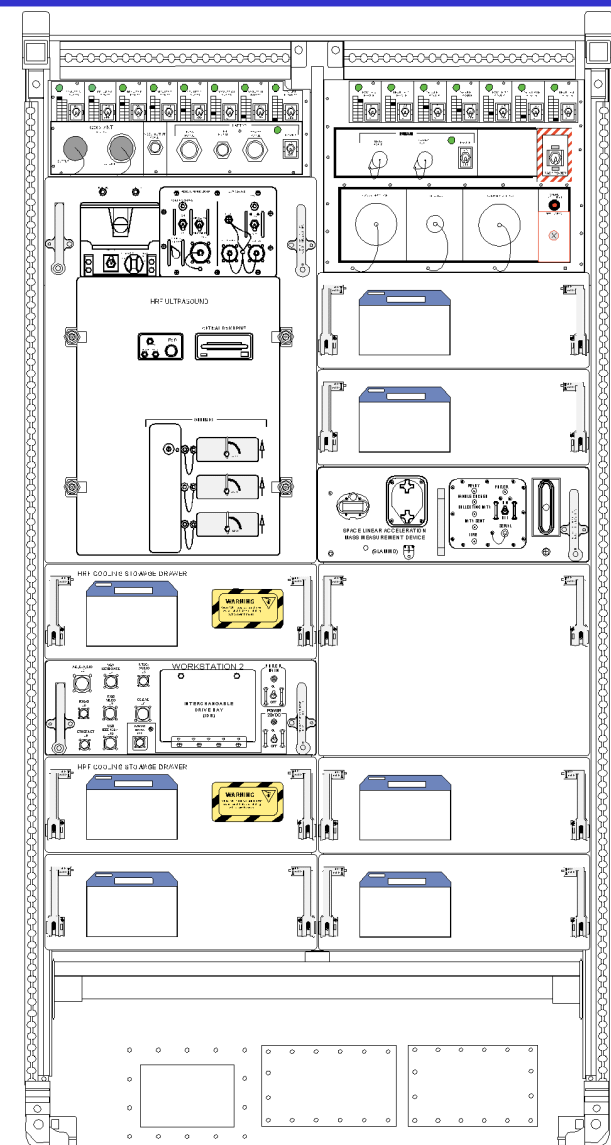
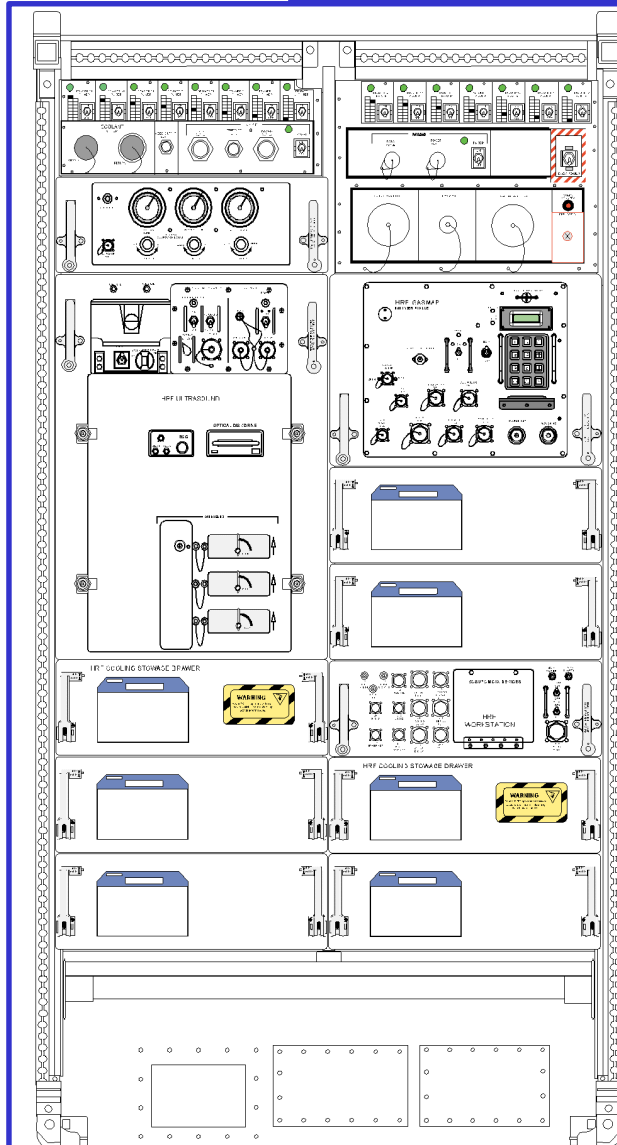
Launch “FR1”

Existing 5A.1 Configuration

On-Orbit “FR1A”

Re-configured during
Increment 7 after FR2 is
installed (ULF-1)

WS2 flown up



FR1A Drawing Tree

- SAG46118552 Flight Rack 1A Arrangement Drawing
- FR1A Components
 - SEG46114550 HRF Ultrasound
 - SEG46118400 Workstation 2
 - SEG46117800 SLAMMD
 - SEG46117144 Cooling Stowage Drawer
 - SEG46118509 ISIS 4 PU Stowage Drawer
 - SEG46113375 HRF 8 PU Stowage Drawer
- SEG46117298 Flight Rack 1 5A.1 Integrated Launch Configuration Drawing
 - SEG46117303 Empty Flight Rack 1 Modification Drawing SAG461182552
 - Acoustic Pouches, Closeout strips, labels
 - 683-46051-4 Human Research Facility Top Assembly (Boeing Empty Rack)
 - SEG46117050 HRF Mixing Fan



FR1A Configuration

- Changes to Rack after 5A.1 and before I7
 - Removed umbilical brackets (flown down)
 - Removed accumulator to use with FR2
 - Changed maintenance switch decal to OFF/ON from ON/OFF (planned for 8A)
- FR1A Configuration
 - Series of studies with inputs from stress, thermal, HFE and operations to create an optimized FR1A layout jointly with FR2 and FR2A configurations
 - Layout moved all actively cooled drawer to left bank. Right bank passive cooled drawers
 - Co-located active drawers with respective stowage drawers
 - Results of those studies as well as the recommended layout were presented to the HRF CCB as CR HLP1-B100-0005
 - CCB approved recommendation and assigned action to HRF to baseline configuration
 - HRF Memo 2T-TM01-160 baselines the FR1A Configuration



FR1A Operational Scenarios

| Scenario | Rack & Laptop | US+ FSD B1-E1 | CSD F1 | WS2+ FSD G1 | CSD H1 | SLAMMD E2 | Target Time | Duty Cycle |
|------------------|---------------|---------------------|-----------|-------------------|-----------|--------------|----------------|---------------|
| Rack only | X | | | | | | 32 | 2/mo |
| US Checkout | X | X | X | | | | 8 | 1/mo |
| US & WS2 | X | X | X | X | X | | 8 | 1/mo |
| WS2 Ops | X | | | X | X | | 24 | 1/wk |
| SLAMMD Ops | X | | | | | X | 8 | 1/wk |
| SLAMMD & WS2 Ops | X | | | X | X | X | 8 | 1/wk |
| All Instruments | X | X | X | X | X | X | 1 | |

Notes:

1. All time in Hours and includes non-crew-tended periods.
2. Configurations from HRF operations staff using known experiments and procedures.
3. Time estimates have not been validated by PTDR or crew training.



FR1A Project Milestones and Schedule

- | | |
|-----------------------------------|---------------|
| • Delta TRR | Sept 06, 2001 |
| • Integration Tests | Sept 2001 |
| • PRCU Calibration | Oct 2001 |
| • EMI and Acoustics | Nov 2001 |
| • Software Integration | Dec 2001 |
| • Verification Tests | Mar 2002 |
| • L-7.5 Verification Delivery | April 2002 |
| • Phase III Safety Review | May 2002 |
| • Mission Success Test | May 2002 |
| • Rack1 GCAR Updated and Complete | June 2002 |
| • Instrument GCAR's Complete | June 2002 |
| • SAR | June 2002 |
| • Deliver hardware to KSC | July 2002 |
| • KSC Integration | Aug 2002 |
| • L-3.5 Verification Delivery | Aug 2002 |
| • CoFR | Sept 2002 |
| • FRR | Oct 2002 |
| • ULF1 Launch | Nov 2002 |
| • On-orbit checkout | Dec 2002 |



FR1A Project Risks and Mitigation

1. Rack 1A on-orbit reconfiguration is a new process
 - Utilize Rack 1 path finding lessons learned
 - Continually involve HRF Team Members and Stakeholders - Continuous communication
2. No Rack 1 for Integration and Verification
 - Utilize the Flight Prototype Rack. Differences between the FPR and the Rack 1 identified and addressed in the closure of requirements
 - Utilize Flight Rack 2: Differences between the FR2 and the Rack 1 will be identified and addressed in closure of requirements
 - Complete as much verification by similarity and analysis.
3. Shared Resources: Analysts, FPR, FR2, LIF, PRCU, Instruments
 - Analysis and Integration and Test Schedule are coordinated schedules reviewed by both the Rack 1A Project Management and the Rack 2/2A management
 - Created a LIF Utilization schedule that optimizes facility and FPR usage
 - Monthly Status Review and Project coordination meeting to determine conflicts and priorities



HRF Flight Rack 2/2A

Elton Witt

Configuration
Project Specifics
Milestones and Schedule
Risk and Mitigation



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HRF FR1A and FR2/2A

Elton Witt

Dec. 7, 2001

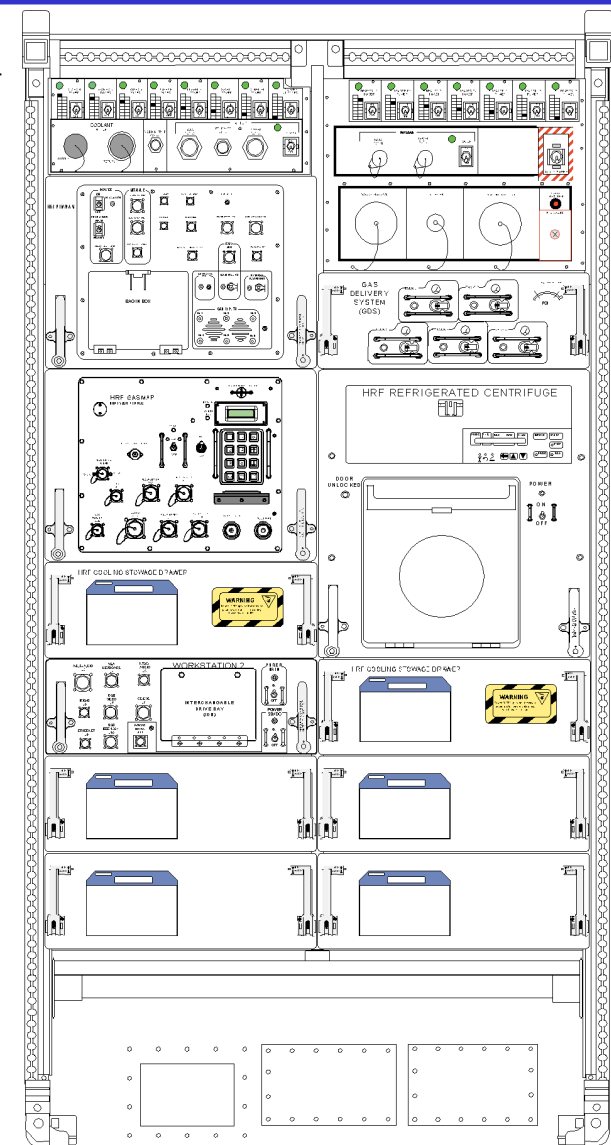
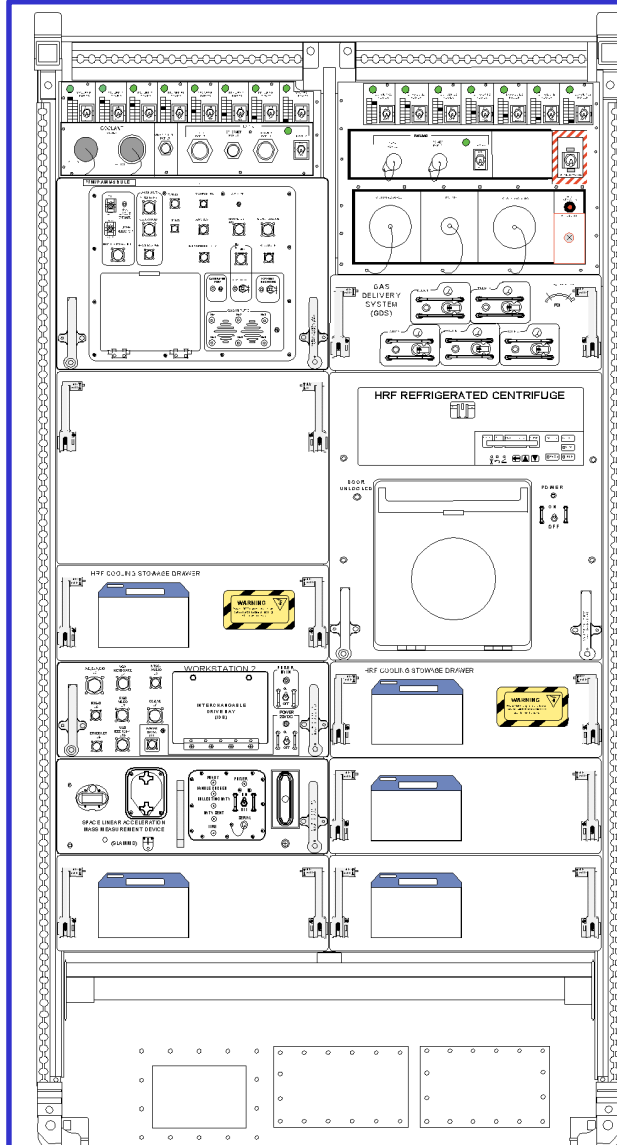
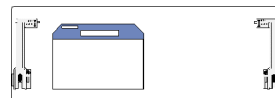
FR2/2A Configuration

Launch “FR2”

On-Orbit “FR2A”

**Re-configured during
Increment 7 after FR2 is
installed (ULF-1) with
GASMAP from FR1**

**4-PU ISIS Stowage Drawer
flown up**



FR2/2A Drawing Tree

- SEG46118353 Flight Rack 2 Integrated Launch Configuration Drawing
- SEG46118354 Flight Rack 2A Integrated On-Orbit Configuration Drawing
- Components
 - PFM/PAM 3100-0000 PFM/PAM
 - SEG46117405 Refrigerated Centrifuge
 - SEG46118400 Rack 2 Workstation
 - SEG46117462 Gas Delivery System (GDS)
 - SEG46117920 GASMAP Analyzer
 - SEG46117800 SLAMMD
 - SEG46117144 Cooling Stowage Drawer
 - SEG46118509 4 PU ISIS Stowage Drawer
 - SEG46113375 8 PU Stowage Drawer
 - SEG46118352 Empty Flight Rack 2 Modification Drawing
 - Acoustic Pouches, Closeout strips, labels
 - 683-46051-4 Human Research Facility Top Assembly (Boeing Empty Rack)
 - SEG46117050 HRF Mixing Fan



FR2/2A Configuration

- Configuration established by CCB
 - Product of Multi-disciplined team using evaluative criteria and scores
 - Moved all PFS instruments into same rack
 - Minimized movement of instruments in rack
 - Balanced power between both racks
 - RC located by itself on right cooling leg
 - PFS instruments located together on left cooling leg
- Labeling
 - FR2 front panel incorporates FR1's label changes into the paint
 - Maintenance switch position left blank by EXPRESS
- Location
 - FR2 to be co-located in APM next to EPM and across isle from FR1



Differences between FR2 and FR1 Empty Racks

- Updated PIDS (Rack Spec) to SSP 57000E
 - Additional testing performed on FR2 for delta Pressure requirement
 - Many requirements closed by similarity as recurring unit
- Mechanical Alignment improved to make 4-PU drawer locations co-planar
 - Added shims and changed alignment procedure
 - Does not change structural dynamics
- Front Panel Labels updated to match FR1 front panel changes
- New firmware in SSPCM
- Accumulator from FR1 was flown down and will be re-used for FR2
- FR2 RIC S/W to be updated soon after Rack delivery



FR2A Reference Operational Scenarios

| Scenario | PFM/PAM B1-C1 | GASMAP D1-E1 | GDS C2 | CSD F1 | WS2 G1 | CSD G2 | RC D2-F2 | Target Time | Duty Cycle |
|------------------|------------------|-----------------|-----------|-----------|-----------|-----------|-------------|----------------|---------------|
| Rack only | | | | | | | | 32 | 2/mo |
| PFM/PAM "PAS" | X | | X | | | | | 32 | 1/mo |
| PFS "MAS" | X | X | X | | | | | 84 | 1/mo |
| PFS 90-day C/O | X | X | X | | | | | 8 | 90d |
| PFS w/WS2 | X | X | X | X | X | | | 8 | 1/mo |
| WS2 | | | | X | X | | | 24 | 1/wk |
| RC | | | | | | X | X | 8 | 1/mo |
| RC/WS2 | | | | X | X | X | X | 8 | 1/mo |
| GASMAP C/O | | X | X | | | | | 16 | 1/mo |
| PFS/RC | X | X | X | | | X | X | 8 | 1/mo |



FR2/2A Milestones and Schedule

- | | |
|------------------------------------|---------------|
| • Empty Rack 2 Delivered to JSC | August 2001 |
| • Rack Modifications Complete | October 2001 |
| • EMI TRR / EMI and Acoustic Tests | Nov-Dec 2001 |
| • Delta TRR for 241 | December 2001 |
| • Software Integration | Jan 2002 |
| • VLA Cycle 1 | Jan 2002 |
| • Verification Tests | Feb-May 2002 |
| • Phase III Safety Review | May 2002 |
| • L-7.5 Verification Delivery | April 2002 |
| • Mission Success Tests | April 2002 |
| • Component Certification | May/June 2002 |
| • SAR | July 2002 |
| • Deliver hardware to KSC | August 2002 |
| • KSC Integration | Aug-Oct 2002 |
| • L-3.5 Verification Delivery | Aug 2002 |
| • CoFR | Sept 2002 |
| • FRR | Oct 2002 |
| • ULF1 Launch | Nov 2002 |
| • On-orbit checkout | Dec 2002 |



FR2/2A Project Risks and Mitigations

1. Definition of Structural Analysis Approach
 - SM provided letter to OZ defining approach for launch loads
2. Instrument Maturity
 - Close coordination with instrument developers
 - Plan test complexity to increase as instrument maturity improves
3. Shared Resources: Analysts, FPR, FR2, LIF, PRCU, Instruments
 - Analysis and Integration and Test Schedule are coordinated schedules reviewed by both the Rack 1A Project Management and the Rack 2/2A management
 - Created a LIF Utilization schedule that optimizes facility and FPR usage
 - Monthly Status Review and Project coordination meeting to determine conflicts and priorities



Risk Summary Action Item Review

Todd Leger

Risks and Issues Summary

| Issue/Risk | Level of Risk | Risk Mitigation |
|--|---------------|---|
| CoFR responsibility for Integrated Rack still TBD | Medium | Either OZ or SM accept responsibility |
| Instrument Maturity | Medium | Schedule design |
| Shared Resources | Medium | Schedule design and timely reviews Core competency and proven track record |
| Rack 1A on-orbit reconfiguration is a new process | Low | Process definition early CCB controlled configuration Verification requirements defined |
| Definition of Structural Analysis Approach for FR2 | Low | Close coordination with OZ Resource management Rack 1 experience |



Action Item Review

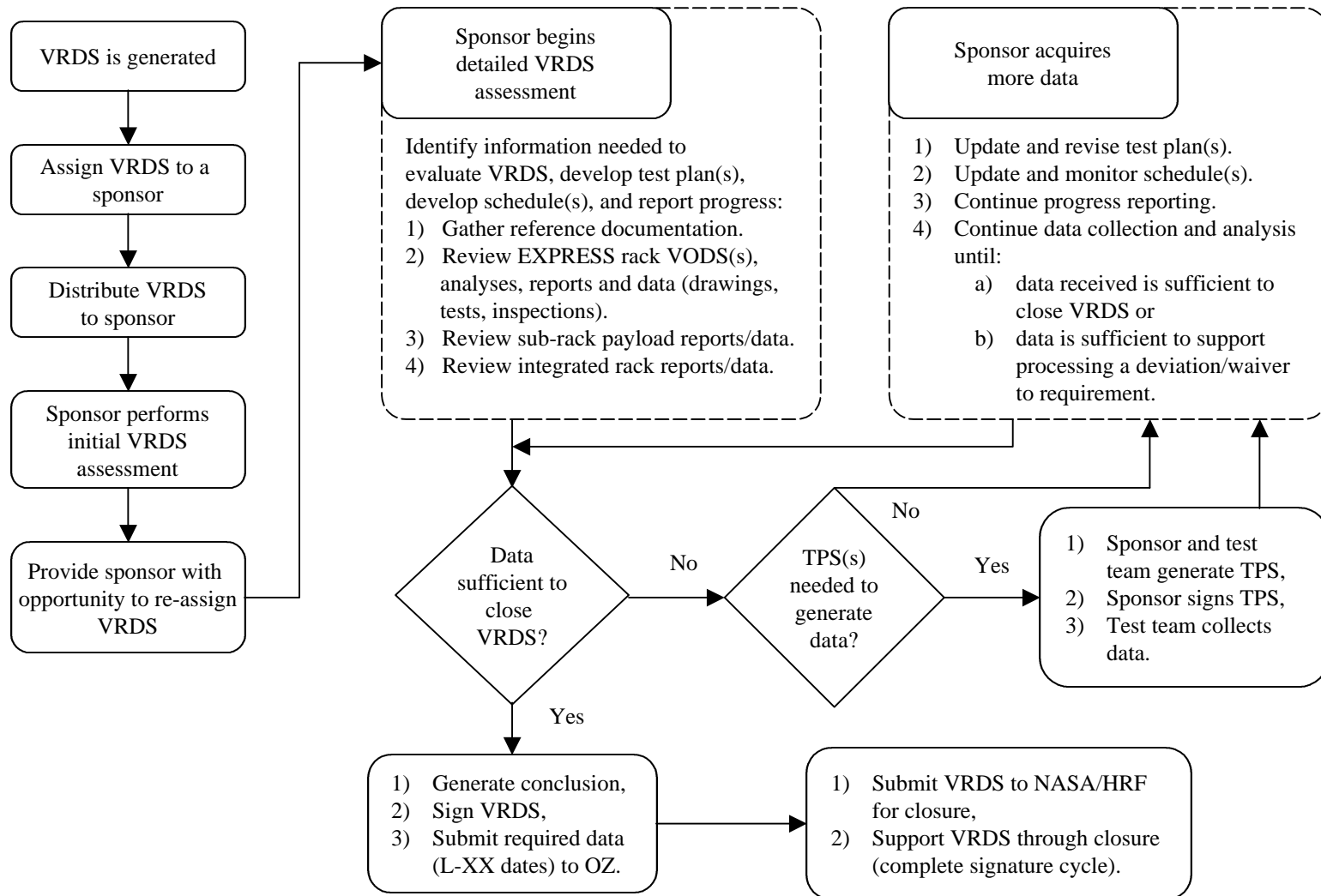
1. SE&I is to develop the configuration definition document prior to completion of FR1A activities. A schedule and plan for the document should also be developed. Actionee: Carlos Aguilar
2. SE&I needs to work with JSC Quality and discuss how PRCU configuration is being documented and controlled. Currently, TPSs do not record the PRCU configuration. PRCU configuration is tracked by the LIF configuration system. Actionee: Todd Leger
3. HRF Ops plans to pre-position the FR1 into a delta configuration in preparation for the change to the FR1A configuration. HRF Increment leads need to present this new configuration to CCB for approval. Actionee: Brad Rhodes
4. HRF needs to develop a way to certify International Partner's HRD requirements for configurations that require hardware other than the HRF hardware such as CHECs hardware. Actionee: Liz Bauer



Backup Slides

Linked to other slides

VRDS Process Flow



PIRN IMPLEMENTATION PROCESS

Payloads Control Board approves an ISS CR containing SSP 57000 or SSP 52050 PIRNS



HRF Systems Engineering Requirements team presents a CR to the HRF CCB to update the approved PIRN list for HRF. This CR must be sponsored by JSC/EB. The CR will contain information concerning any exceptions which JSC/OZ has agreed to grant during the PCB which approved the ISS CR.



HRFCCB approves CR.



HAX and HHX task order managers coordinate activities required to comply with the newly approved PIRNS. These activities include contract modification, analysis/test, hardware modification, support during exception process, and support to RCAR.



HRF Systems Engineering Verification team develops RCAR materials consistent with newly approved PIRNs.

